Daily Maximum Criteria Assessment – Pend Oreille River TMDL

Region 10 conducted a daily comparison analysis on all instances where the applicable daily maximum criteria were exceeded in the "with dams" model simulations. The exceedances which were greater than the TMDL allocation for a given reach were evaluated for time lag effects from weather events. Flow data and weather data from the time of the exceedances were reviewed to determine if the time lag oscillations exist and were likely to have been caused by natural processes. The natural and existing conditions simulations were plotted at the time of the exceedance to check for time lag effects. If time lag offsets were observed, the date stamp of the existing condition was adjusted to align the pattern of variation in natural conditions and existing conditions.

The results of this analysis found 24 instances (date and segment combinations) where the daily maximum criteria were exceeded beyond the reductions called for in the TMDL. All of these occurred in 2004. Nineteen are exceedances of the state criterion, five are exceedances of the tribe's criterion. Sixteen exceedances occurred during a major storm and flow event in late August 2004. Six occurred during a storm between June 29 and July 1, 2004. When the data is corrected for time lag offsets all but 4 of the 24 exceedances are eliminated or reduced to a magnitude addressed by the TMDL allocations. The details of the analysis are described below in the "Daily Maximum Analysis" section.

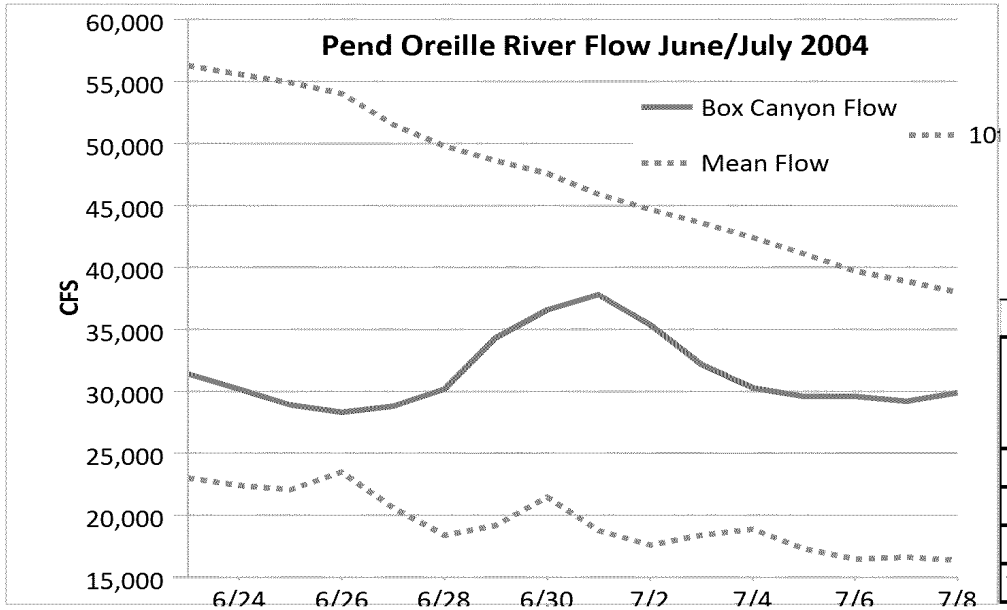
Three of the four exceedances that do not show time lag offsets occur on August 27 through 29, 2004, immediately upstream of the Kalispel Reservation boundary. These are excursions above the Kalispel Tribe 20.5 C daily maximum criteria that are greater than the 0.27 C reduction required of Box Canyon Dam at the Kalispel boundary. The exceedances over the TMDL allocation are 0.54C, 0.43 C and 0.45 C (see graph on page 21). Flow data from the USGS gage station at Box Canyon dam show a near doubling of the river flow between August 25th and 30th, from mean flow levels to levels in excess of the 90th percentile flow for this site (see graph on page 9).

The fourth exceedance that does not show time lag effects occurs on June 24, 2004, in Box Canyon forebay. It is an exceedance of the state's 20C daily maximum criteria, that is 0.18 C over the 1.13 C reduction required at Box Canyon forebay (see graph on page 25). If the portion of the human use allowance that the TMDL allocates to Box Canyon Dam is considered this exceedance is 0.06 C over the TMDL reductions.

Daily Maximum Criteria Exceedances Analysis for the Pend Oreille River by Storm or Weather event

June 29 – July 1, 2004:

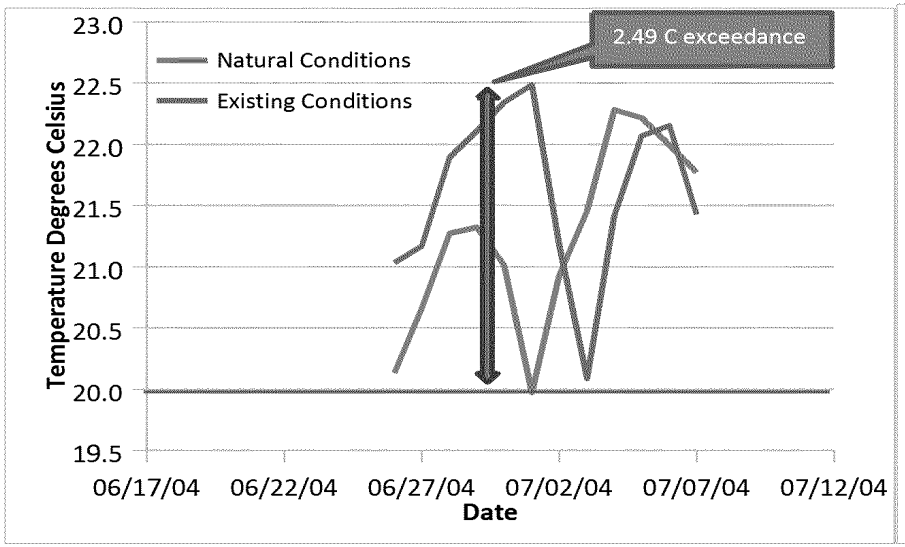
Region 10's analysis of the Pend Oreille River model data using a daily comparison method shows six exceedances of the applicable daily maximum criteria (State's site specific and Kalispel Tribe) that also exceed the TMDL allocations between June 29 – July 1, 2004. Five are exceedances of the state's criterion and the sixth is an exceedance of the Kalispel criterion at the reservation boundary. All the exceedances are in the Box Canyon Reservoir area. Flow data from Box Canyon Dam during this time shows a 7,600 cfs spike in flow starting June 28th and peaking on July 1. Flow levels in general are lower than normal at this time of year (see graph of flow). Weather stations near Box Canyon Dam recorded significant amounts of rain in this time frame (see table of precipitation data). The flow and weather data show that there was a storm and increase of river flow that likely caused a significant cooling effect on river temperatures. The cool water flow would have reached the same location earlier in the natural conditions model simulation than in the existing conditions simulation, because dams slow the flow of water. Therefore we graphed both simulation results for the timeframe around these exceedences to evaluate these time lag effects. All of the graphs of these events show evidence of time lag with a 1 or 2 day shift between the natural conditions and existing conditions model scenarios. When the shift is removed there are no exceedances of the criteria that are unaddressed by the TMDL allocations.



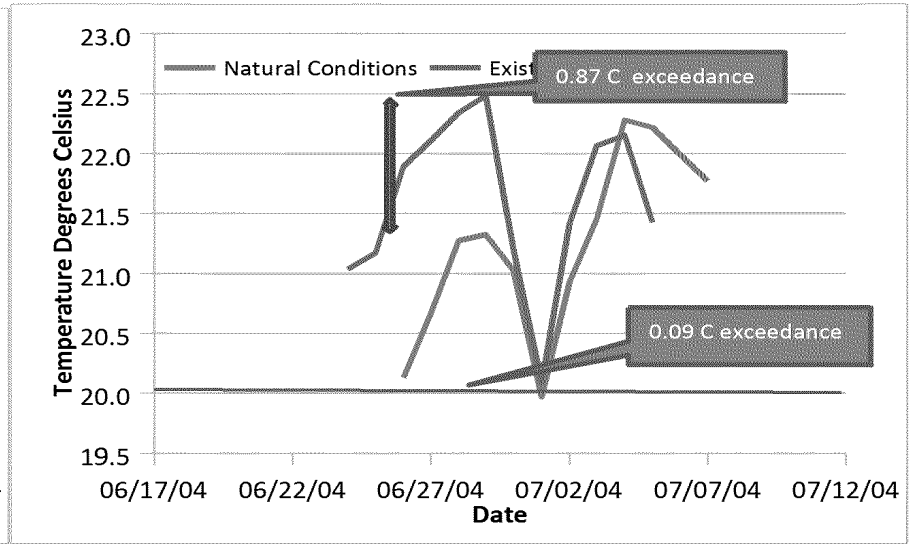
Precipitation in Inches at Pend Oreille Area Stations				
	Deer Park Airport	Newport Airport	Felts Field	Tacoma Creek
6/29/2004	0.22	0	0	0.03
6/30/2004	0.2	0.48	0.13	0.01
7/1/2004	0	0	0	0.76
Total	0.42	0.48	0.13	0.8

Reach: Box Canyon Forebay
Date: July 1, 2004
Segment: 360
River Mile: 34.6
Applicable Criterion: State daily max. 20C
Applicable Allocation: 1.13 C reduction at Box Canyon Dam + 0.02 C reductions expected from riparian vegetation increase = 1.15C

Daily Comparison: 2.49 exceedance which is 1.36 C over the allocation

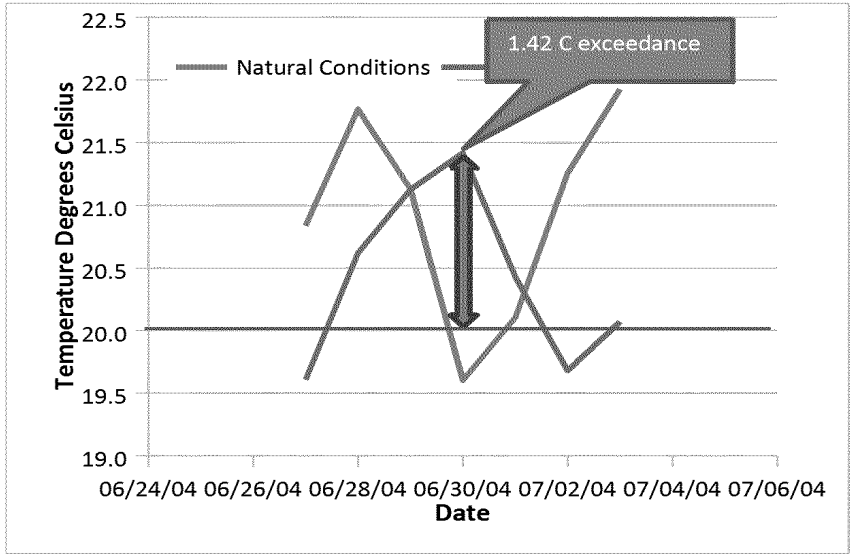


With Time lag adjusted for: 0.87 C natural conditions criteria exceedance; **addressed by allocation** & 0.09 C daily maximum criteria exceedance, **addressed by allocation**

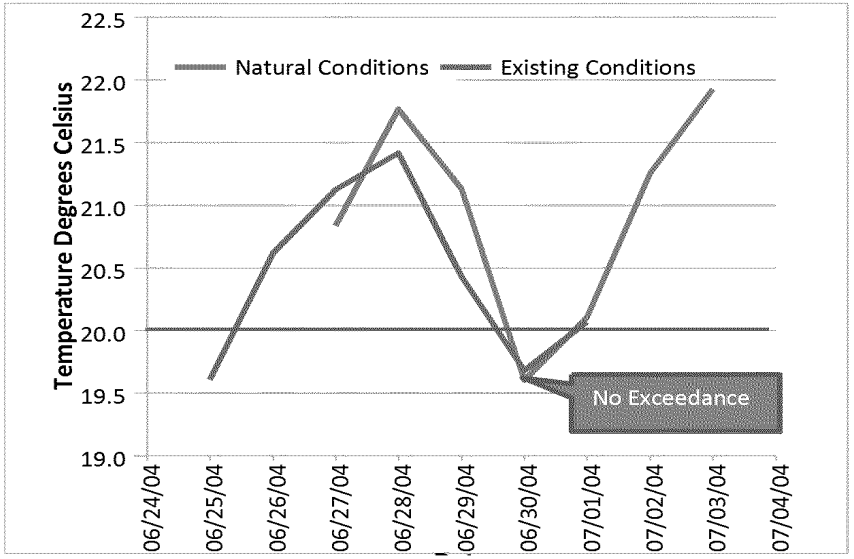


Reach: Middle
Date: June 30, 2004
Segment: 196
River Mile: 63.6
Applicable Criterion: State daily max 20 C
Applicable Allocation: 1.13 C reduction at Box Canyon Dam + 0.02 C reductions expected from riparian vegetation increase = 1.15C

Daily Comparison: 1.42 C exceedance, 0.19 C over allocation.

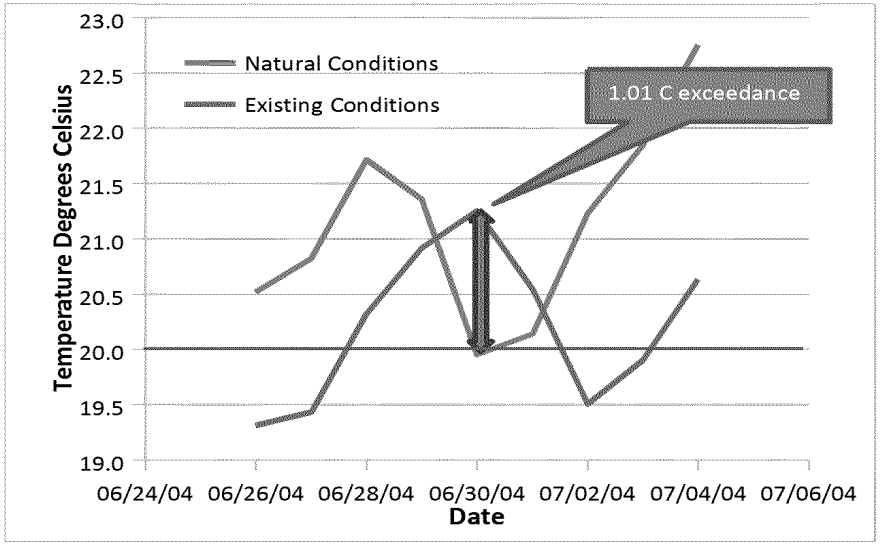


With Time lag adjusted for: **No exceedances**

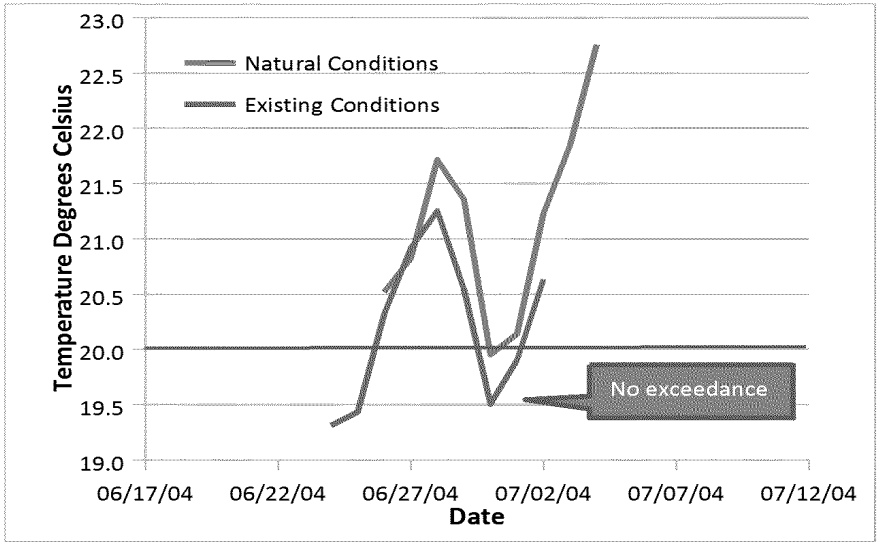


Reach: Blueside
Date: June 30, 2004
Segment: 223
River Mile: 55.7
Applicable Criterion: State daily max 20C
Applicable Allocation: 1.13 C reduction at Box Canyon Dam + 0.02 C reductions expected from riparian vegetation increase = 1.15C and 0.27 C at Kalispel Reservation Boundary +0.02 C reductions expected from riparian vegetation increases = 0.29 C – This point is between the two allocation points

Daily Comparison: 1.01 C exceedance; greater than Kalispel border reduction

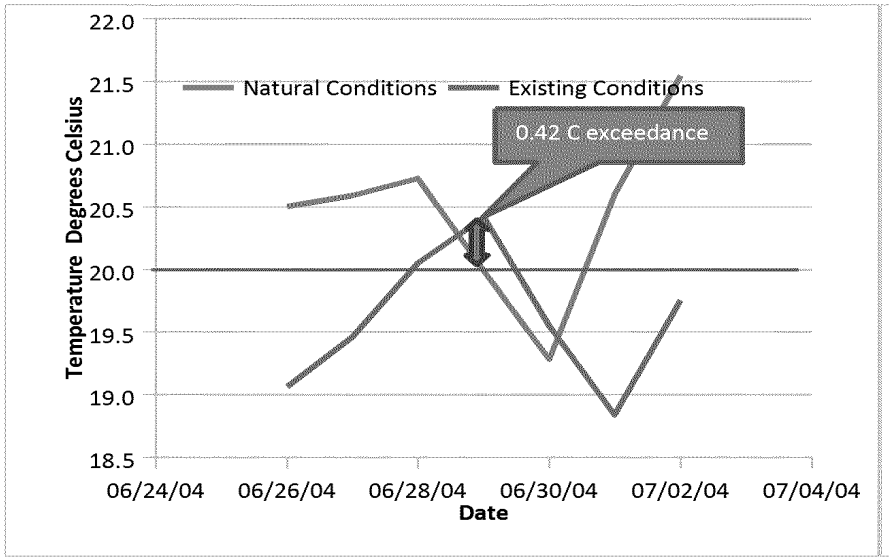


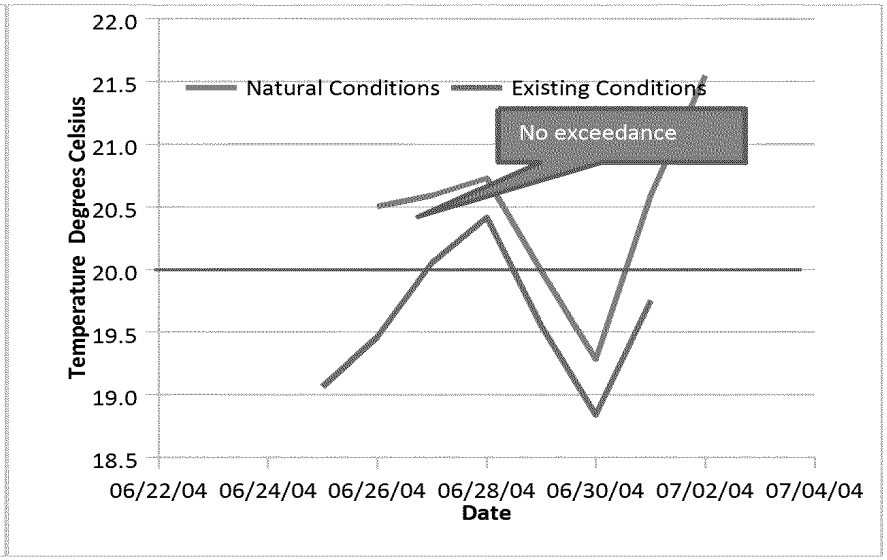
With Time lag adjusted for: **No exceedances**



Reach: Dalkena
Date: June 29, 2004
Segment: 67
River Mile: 80
Applicable Criterion: State daily max 20C
Applicable Allocation: 1.13 C reduction at Box Canyon Dam + 0.02 C reductions expected from riparian vegetation increase = 1.15C and 0.27 C at Kalispel Reservation Boundary +0.02 C reductions expected from riparian vegetation increases = 0.29 C – This point is between the two allocation points

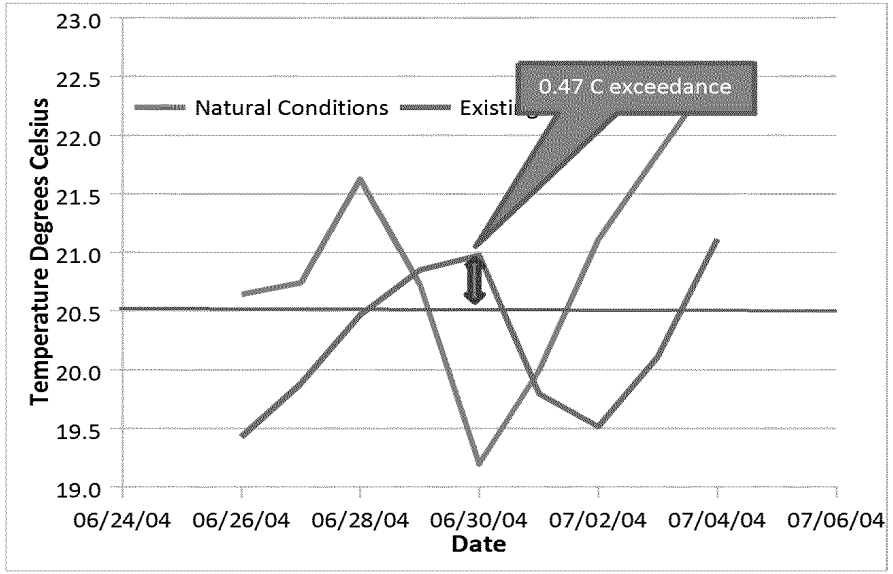
Daily Comparison: 0.42 C exceedance; greater than Kalispel border reduction **With Time lag adjusted for**: **No exceedances**



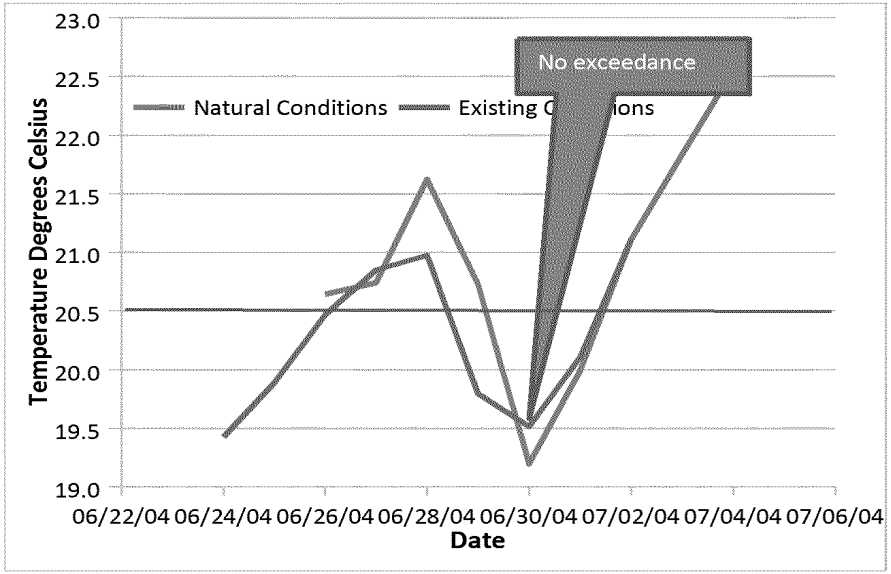


Reach: Middle
Date: June 30, 2004
Segment: 172
River Mile: 63.6
Applicable Criterion: Kalispel daily max 20.5C
Applicable Allocation: 0.27 C at Kalispel Reservation Boundary +0.02 C reductions expected from riparian vegetation increases = 0.29 C

Daily Comparison: 0.42 C exceedance; 0.018 C over Kalispel border reduction



With Time lag adjusted for: **No exceedances**



August 24 and August 29, 2004:

Region 10's analysis of the Pend Oreille River model data from Washington using a daily comparison method shows twelve exceedances of the daily maximum criteria that also exceed the TMDL allocations occurring between August 24 – 29, 2004. Ten are exceedances of the state's criterion and two are exceedances of the Kalispel criterion at the reservation boundary. Six exceedances are in the Box Canyon Reservoir area and the rest are in the Boundary Reservoir. This is the only time period when the model shows exceedances of the daily maximum criteria in excess of the TMDL allocations in Boundary reservoir.

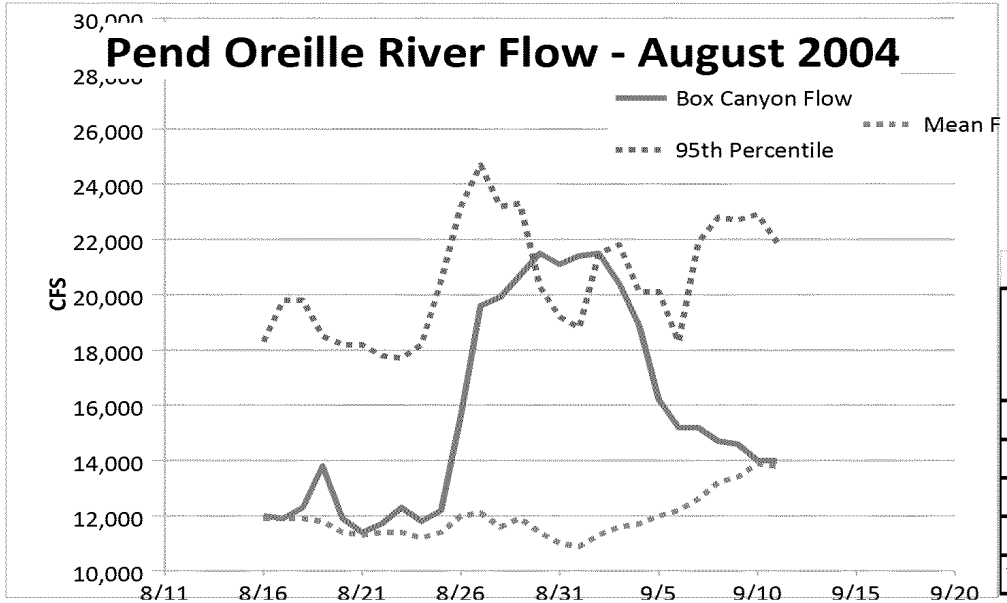
Both flow and weather data from this time frame show that a large storm occurred with unseasonably cool air temperatures, large amounts of rain and flow increases that are among the maximums recorded at this site in 58 years of data. Flow data from the USGS station at Box Canyon Dam shows a 10,000 cfs increase between August 25th and August 30th nearly doubling the flow in the impounded river at that time (see graph of flow). This magnitude of variation over a short time frame likely impacts the accuracy of model predictions, because boundary conditions are not monitored continuously and do not reflect short-term changes (particularly river temperature at the upstream boundary of the model).

Under natural conditions, with no impoundment, the volume of water in the river would be much less and the cooling effects of such an unusual storm event would be faster and of a greater magnitude than under existing, impounded conditions. Weather stations throughout the area recorded significant amounts of rain in this time frame (see table of precipitation data). Unusually low air temperatures and significant cloud cover were also recorded between August 22 and August 26 (see graphic from Sandpoint airport station).

Because dams slow the flow of water, the cooling effects of such a storm and flow increase will show up earlier in the natural conditions model simulation than in the existing conditions simulation, this is called "time lag". Both simulation results for the timeframe around each exceedance were graphed to evaluate and correct for time lag effects. All but one of the graphs of these events show evidence of time lag between the natural conditions and existing conditions model scenarios. When the time lag shift is removed from those graphs showing time lag, there are no exceedances of the criteria that are unaddressed by the TMDL allocations.

The instance where no time lag shows in the graph is for a three day period of exceedances in the Skookum Reach at the upstream boundary with the Kalispel Tribe Reservation. It is an exceedance of the Kalispel Tribal criterion that is, on average, 0.5 C in excess of the reductions mandated by the TMDL at the reservation boundary. The Skookum Reach has a unique bathymetry that is discussed in the TMDL. The TMDL analysis showed it to be impaired when the adjacent upstream and downstream reaches were not. This is due to the presence of a side channel that is inundated by Box Canyon Reservoir. Models are at their lowest accuracy when conditions change rapidly, as in a rapid doubling of the

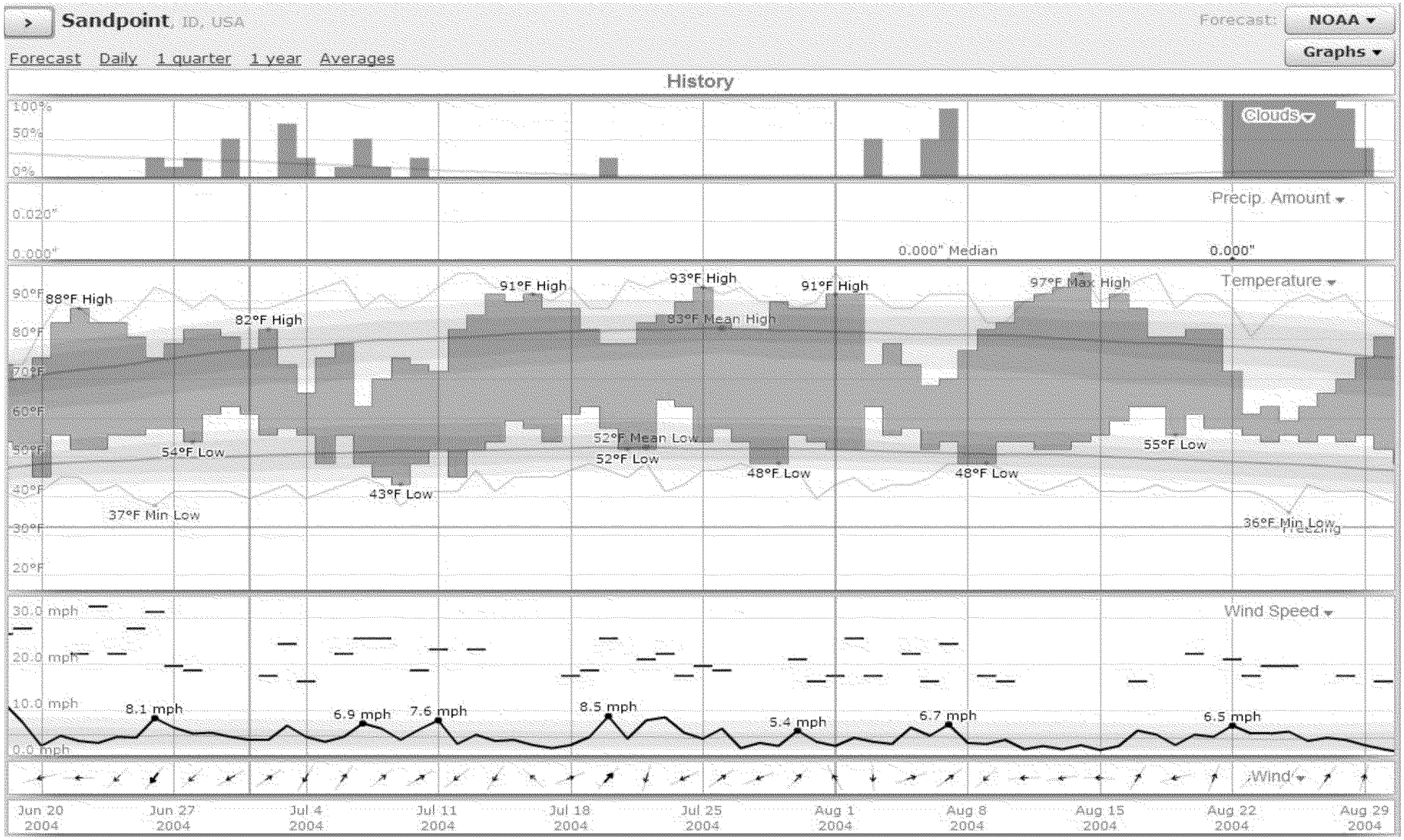
stream flow, which may cause additional uncertainty about the validity of these model results.



Pend Oreille Weather Stations Precipitation (inches)

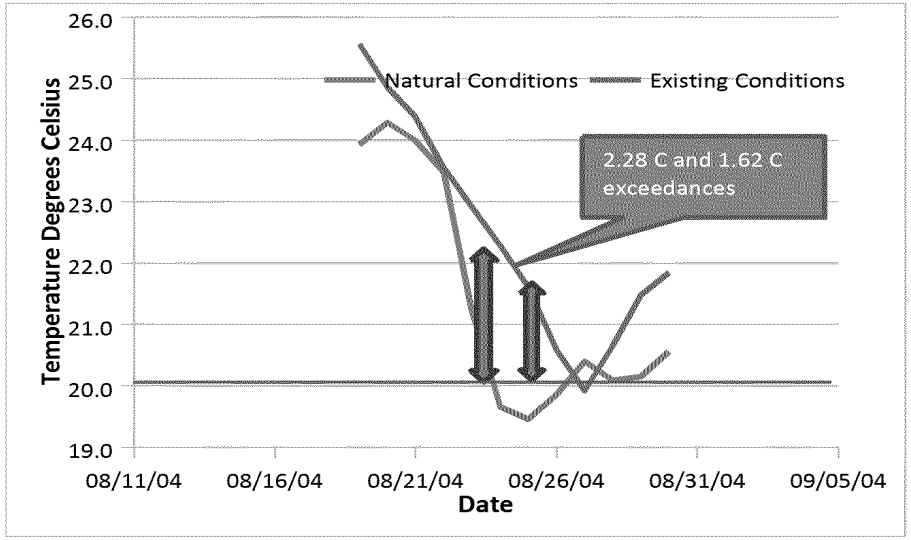
	Sandpoint	Deer Park Airport	Newport Airport	Flowery Trail
8/24/2004	0.11	1.28	0.42	0.6
8/25/2004	1.8	0.22	1.46	0.56
8/26/2004	0.69	0.08	0.14	0.25
8/27/2004	0.27	0	0.02	0.13
Total	2.87	1.58	2.04	1.54

Weather Data for Sanpoint in the summer of 2004 – Note unusually cool temperatures between August 24 and 29.

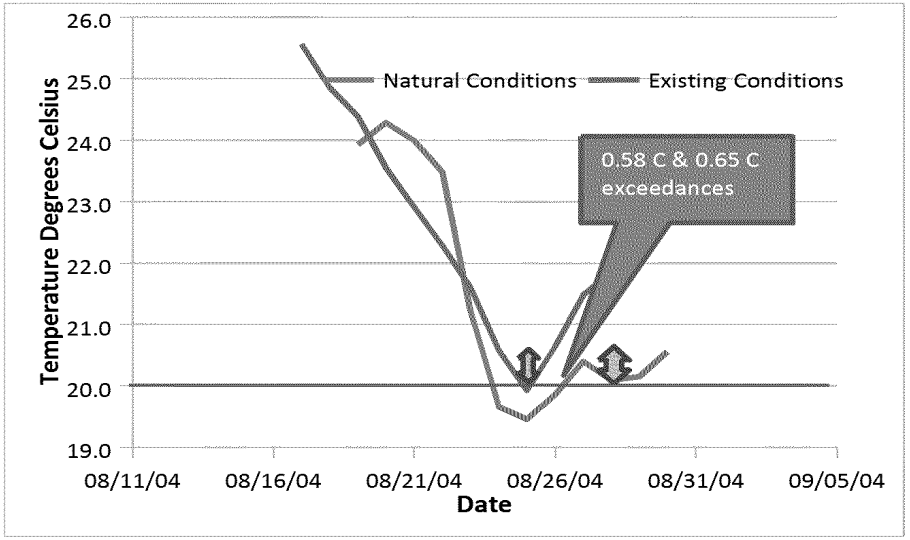


Reach: Box Canyon Forebay
Date: August 24 &25, 2004
Segment: 360
River Mile: 36.4
Applicable Criterion: State daily max 20C
Applicable Allocation: 1.13 C reduction at Box Canyon Dam + 0.02 C reductions expected from riparian vegetation increase = 1.15C

Daily Comparison: 2.28 C and 1.62 exceedances, 1.15 C and 0.49 over allocation.

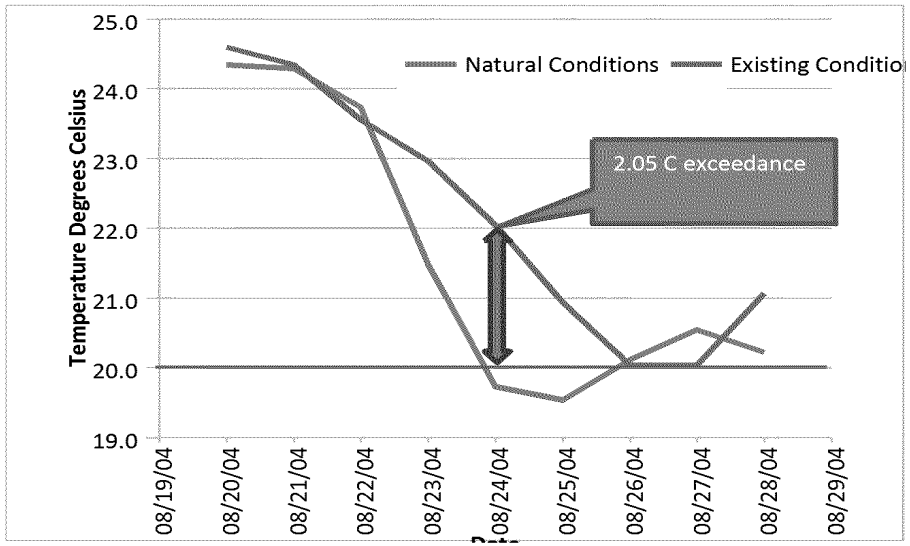


With Time lag adjusted for: 0.58 and 0.65 C exceedances, **addressed by allocation**.

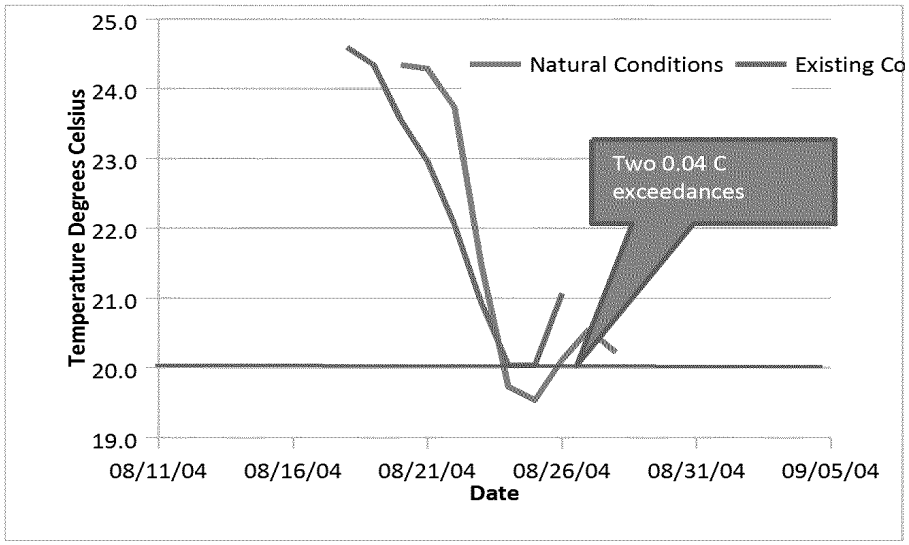


Reach: Tiger
Date: August 24, 2004 Segment: 316-319
River Mile: 41
Applicable Criterion: State daily max 20C
Applicable Allocation: 1.13 C reduction at Box Canyon Dam + 0.02 C reductions expected from riparian vegetation increase = 1.15C

Daily Comparison: 2.05 C exceedance; 0.92 C over allocation.

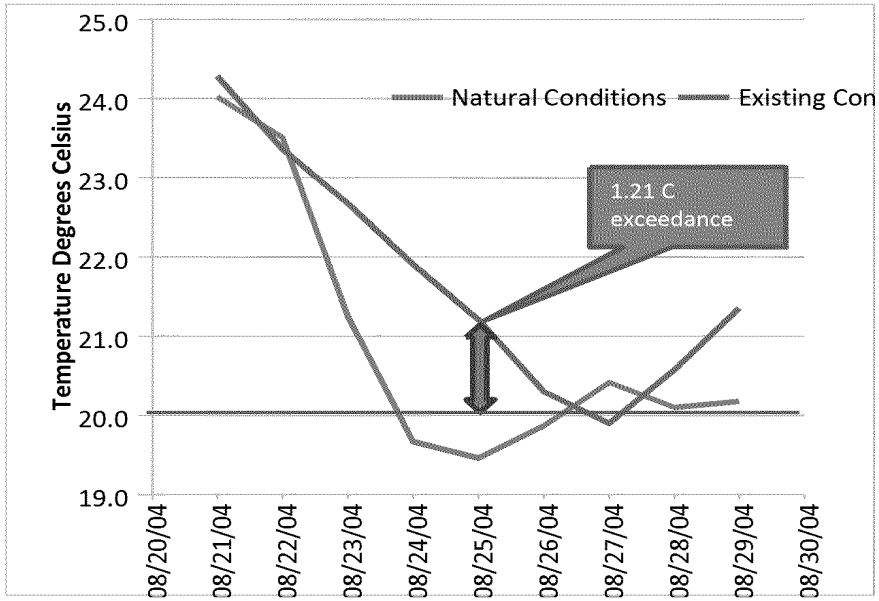


With Time lag adjusted: Two 0.04 C exceedances, **<u>addressed by allocation</u>**

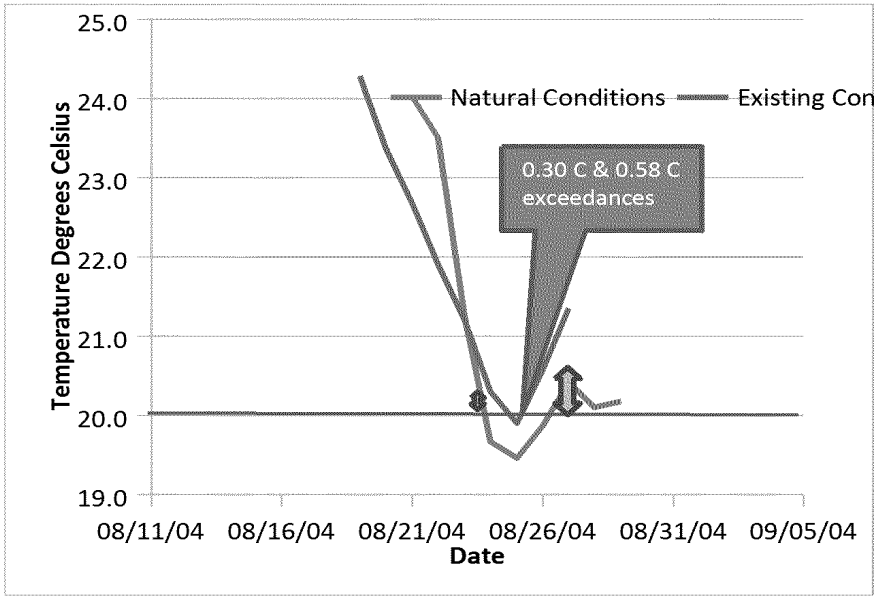


Reach: Tiger
Date: August 25, 2004
Segment: 347
River Mile: 36.4
Applicable Criterion: State daily max 20C
Applicable Allocation: 1.13 C reduction at Box Canyon Dam + 0.02 C reductions expected from riparian vegetation increase = 1.15C

Daily Comparison: 1.21 C exceedance; 0.08 C over allocation.

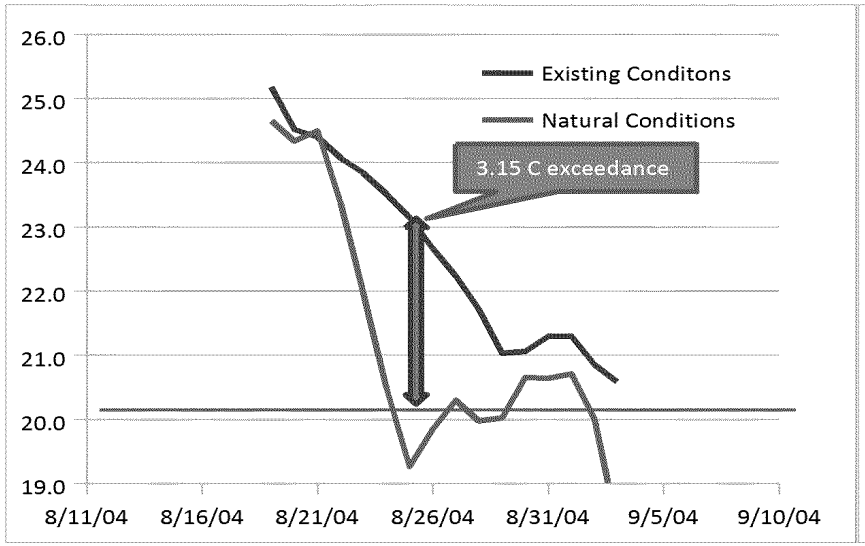


With Time lag adjusted: Two exceedances: 0.30 C and 0.58C; **addressed by allocation**.

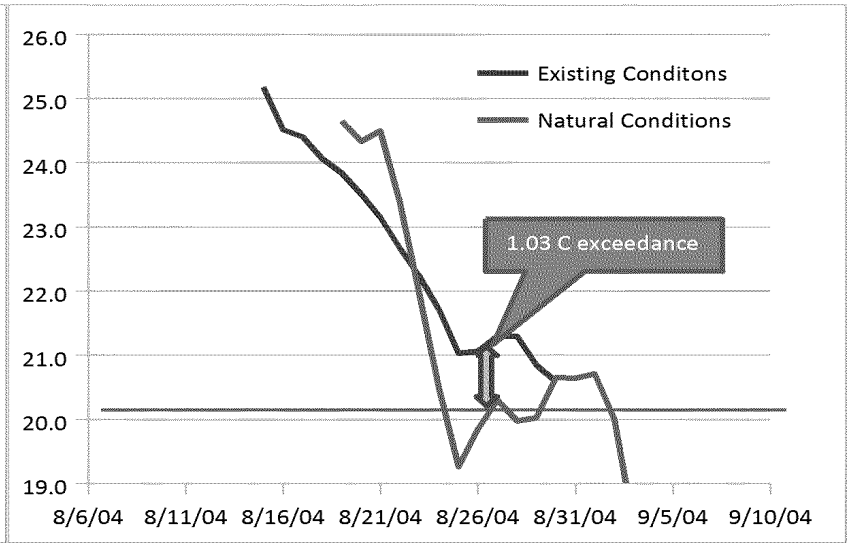


Reach: Boundary Forebay
Date: August 25, 2004
Segment: 110
River Mile: 17.3
Applicable Criterion: State daily max 20C
Applicable Allocation: 0.76 C at Boundary Dam +1.13 C reduction at Box Canyon Dam + 0.02 C reductions expected from riparian vegetation increase = 1.91C

Daily Comparison: 3.15 C exceedance; 1.24 C over allocations.

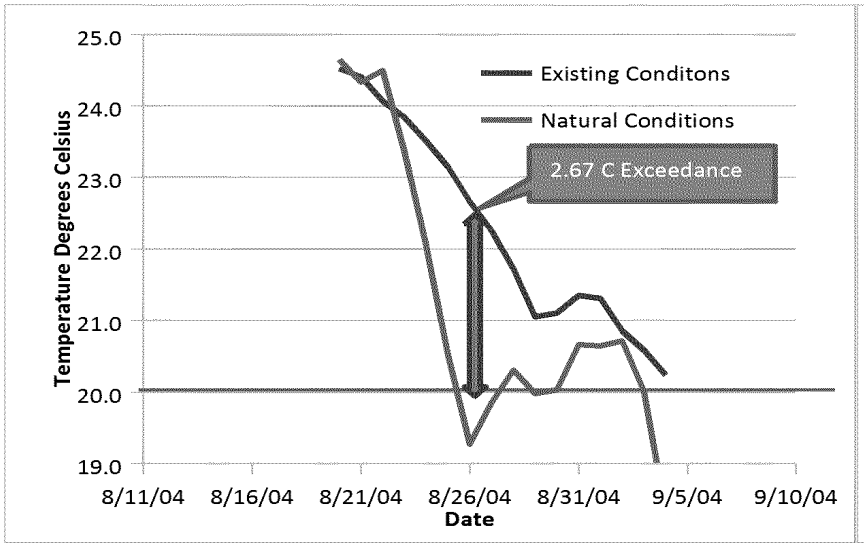


With Time lag adjusted: 1.03 C exceedance; **addressed by allocation.**

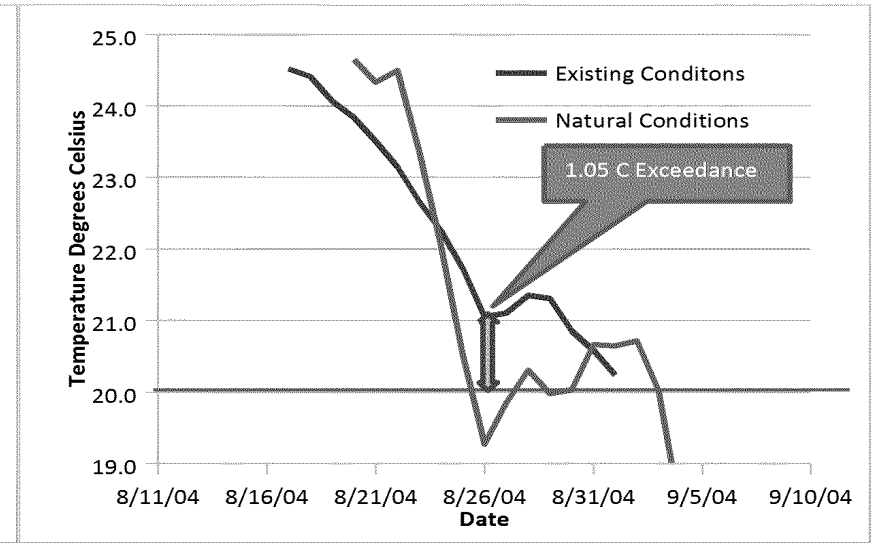


Reach: Boundary Forebay
Date: August 26, 2004
Segment: 111
River Mile: 17.1
Applicable Criterion: State daily max 20C
Applicable Allocation: 0.76 C at Boundary Dam +1.13 C reduction at Box Canyon Dam + 0.02 C reductions expected from riparian vegetation increase = 1.91C

Daily Comparison: 2.67 C exceedance; 0.76 C over allocations.

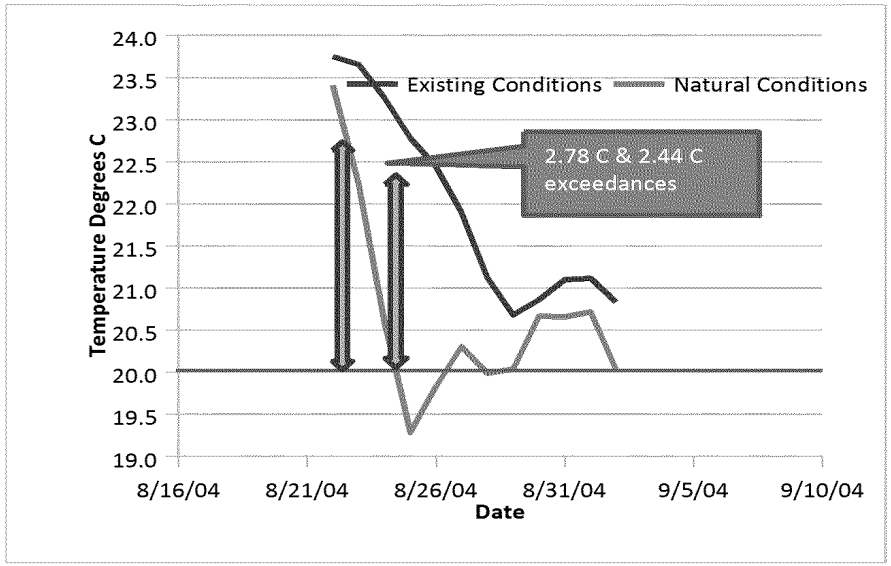


With Time lag adjusted: 1.05 C exceedance; **addressed by allocations.**

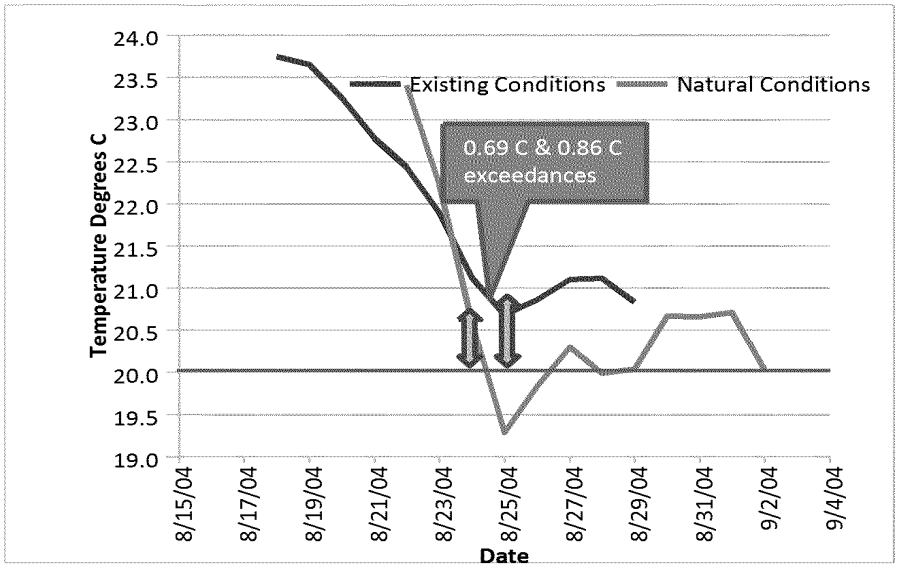


Reach: Boundary Tailrace
Date: August 25 &26, 2004
Segment: 117
River Mile: 16.8
Applicable Criterion: State daily max 20C
Applicable Allocation: 0.76 C at Boundary Dam +1.13 C reduction at Box Canyon Dam + 0.02 C reductions expected from riparian vegetation increase = 1.91C

Daily Comparison: 2.78 C & 2.44 C exceedances; 0.87 C & 0.53 C over allocations.

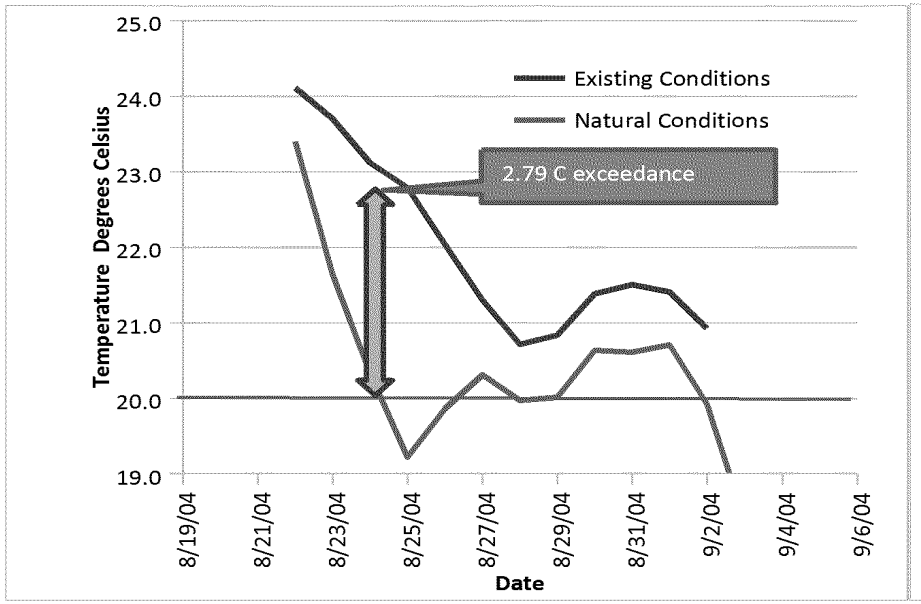


With Time lag adjusted: 0.86 C & 0.69 C exceedances; **addressed by allocations.**

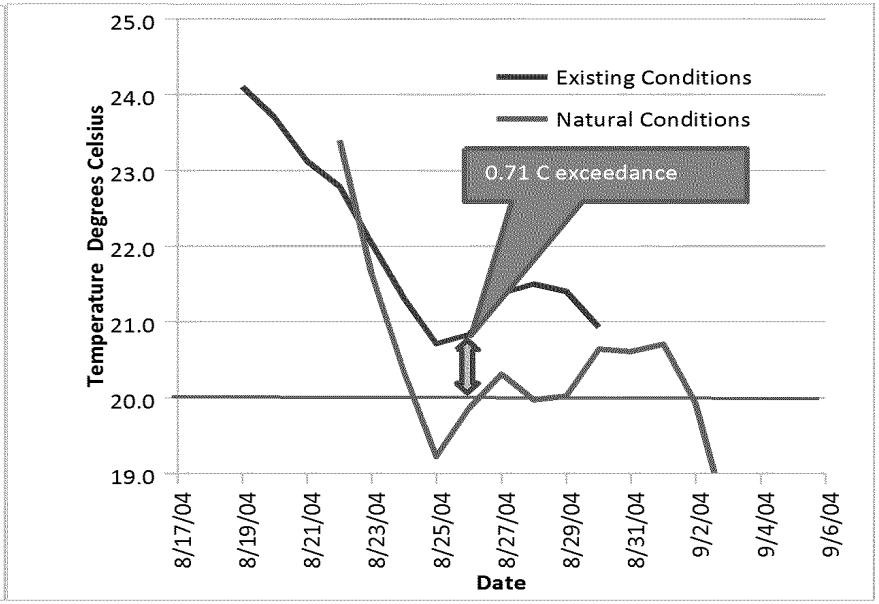


Reach: Slate
Date: August 25, 2004
Segment: 96
River Mile: 19.5
Applicable Criterion: State daily max 20C
Applicable Allocation: 0.76 C at Boundary Dam +1.13 C reduction at Box Canyon Dam + 0.02 C reductions expected from riparian vegetation increase = 1.91C

Daily Comparison: 2.79 C exceedance; 0.88 C over allocations.

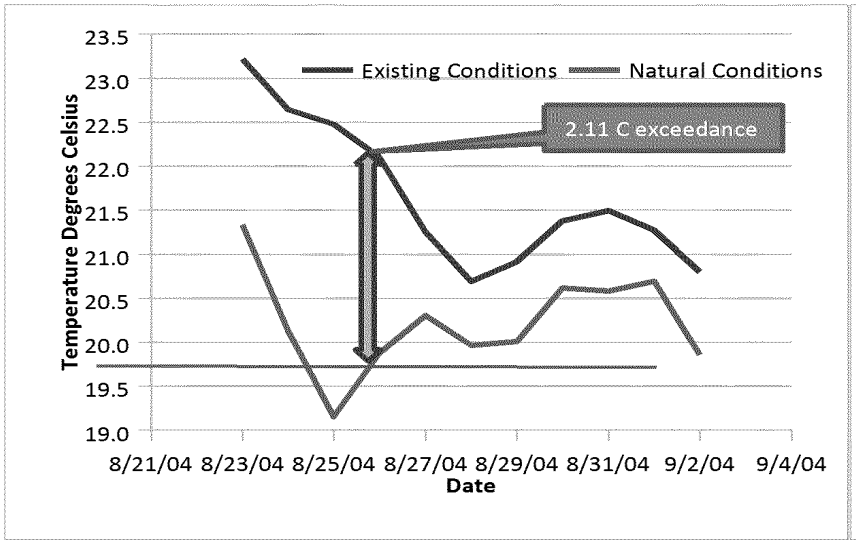


With Time lag adjusted: 0.71 C exceedance; **<u>addressed by allocation.</u>**

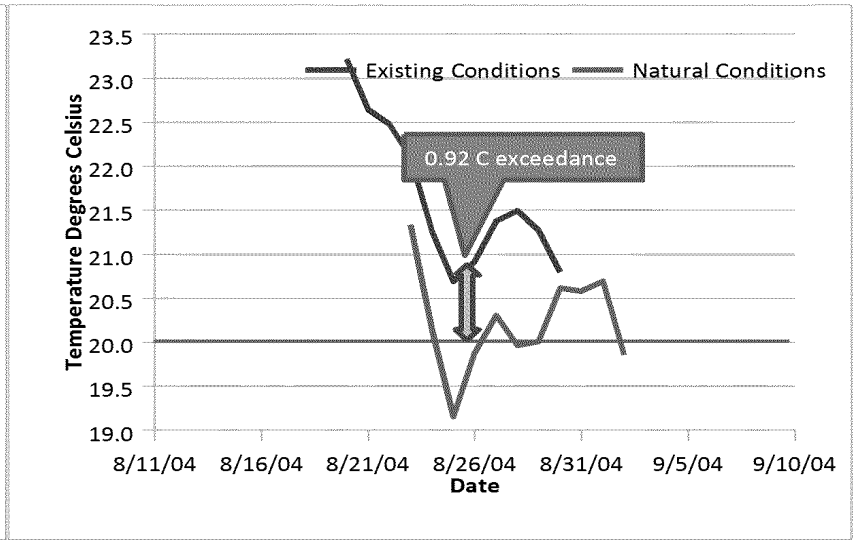


Reach: Slate
Date: August 26, 2004
Segment: 88
River Mile: 21.2
Applicable Criterion: State daily max 20C
Applicable Allocation: 0.76 C at Boundary Dam +1.13 C reduction at Box Canyon Dam + 0.02 C reductions expected from riparian vegetation increase = 1.91C

Daily Comparison: 2.11 C exceedance; 0.20 C over allocations.



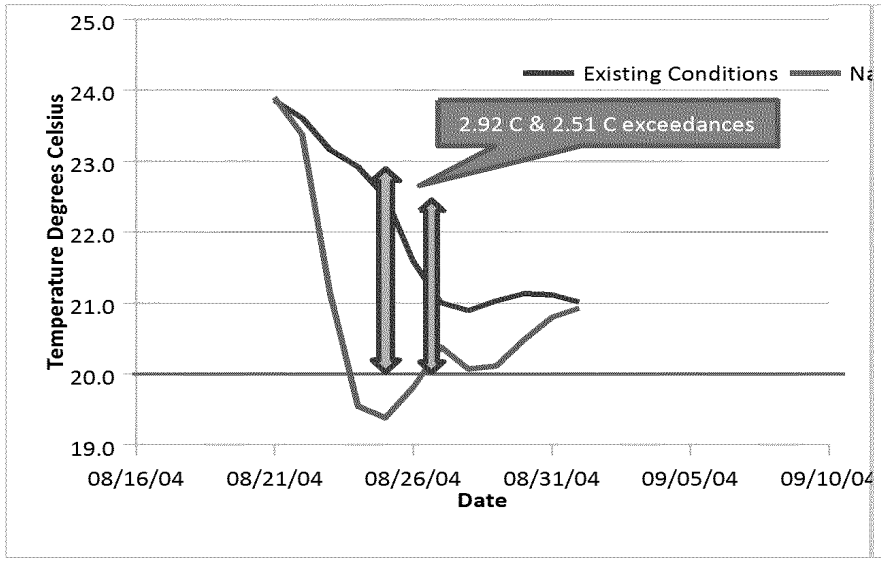
With Time lag adjusted: 0.92 C exceedance; **<u>addressed by allocation.</u>**

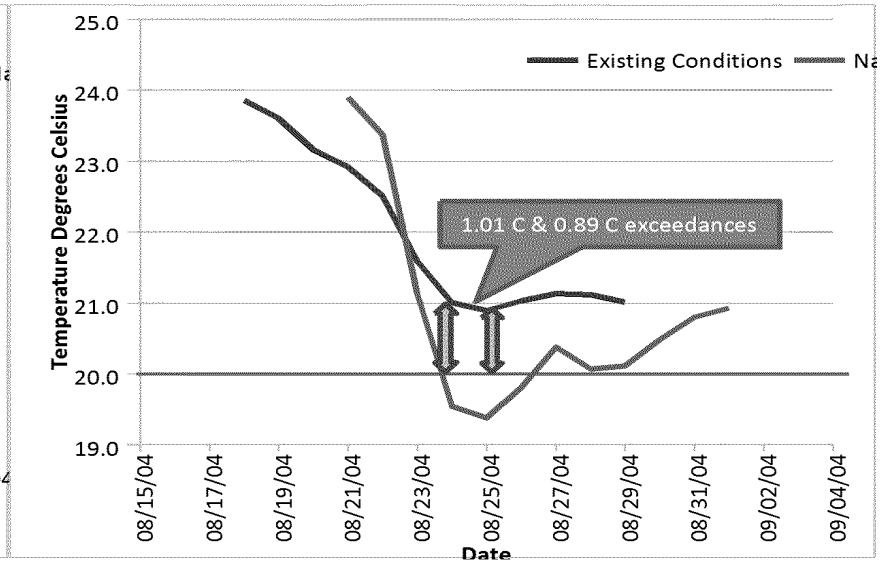


Reach: Metaline
Date: August 24 & 25, 2004
Segment: 2
River Mile: 34.4
Applicable Criterion: State daily max 20C
Applicable Allocation: 0.76 C at Boundary Dam +1.13 C reduction at Box Canyon Dam + 0.02 C reductions expected from riparian vegetation increase = 1.91C

Daily Comparison: 2.92 C & 2.51 C exceedances; 0.99 C & 0.60 C over allocations.

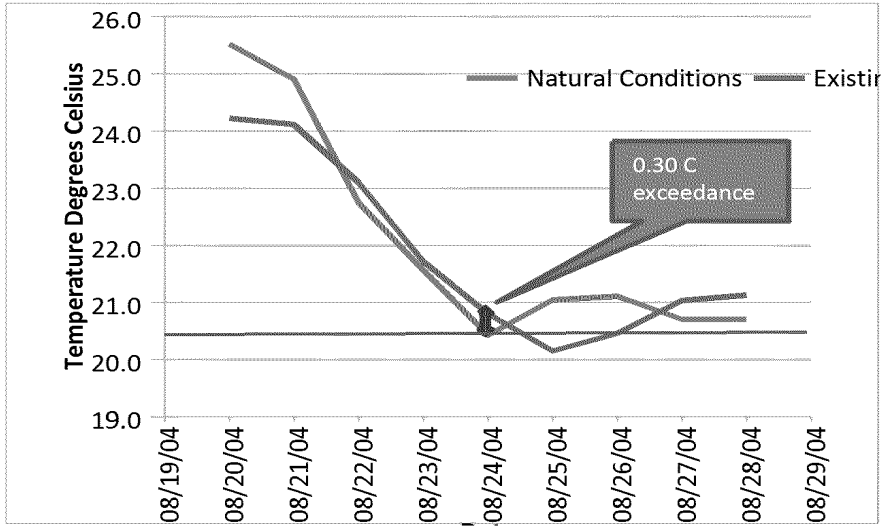
With Time lag adjusted: 1.01 C & 0.89 C exceedances; **addressed by allocation**.



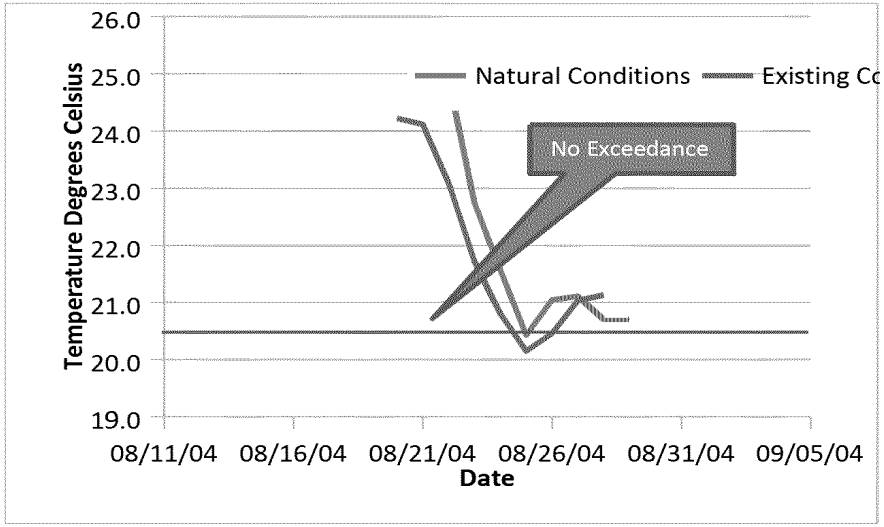


Reach: Middle
Date: August 24, 2004
Segment: 172
River Mile: 36.4
Applicable Criterion: Kalispel daily max 20.5C
Applicable Allocation: 0.27 reduction required at the Kalispel Boundary + 0.02 C reductions expected from riparian vegetation increase = 0.29C

Daily Comparison: 0.30 C exceedance; 0.03 C over Kalispel border reduction

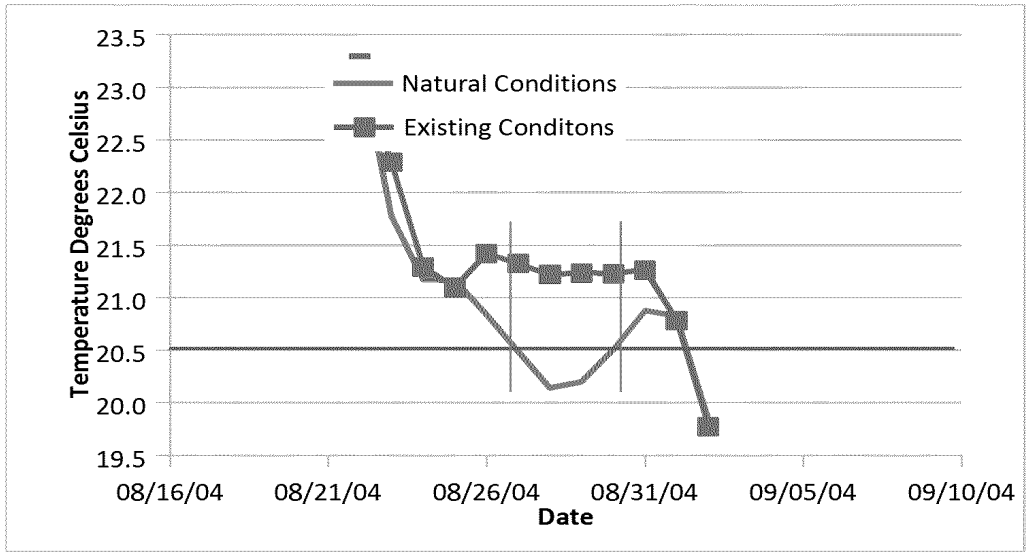


With Time lag adjusted: **<u>No exceedance</u>**



Reach: Skookum
Date: August 27 - 29, 2004
Segment: 115
River Mile: 36.4
Applicable Criterion: Kalispel daily max 20.5C
Applicable Allocation: 0.27 reduction required at the Kalispel Boundary + 0.02 C reductions expected from riparian vegetation increase = 0.29C

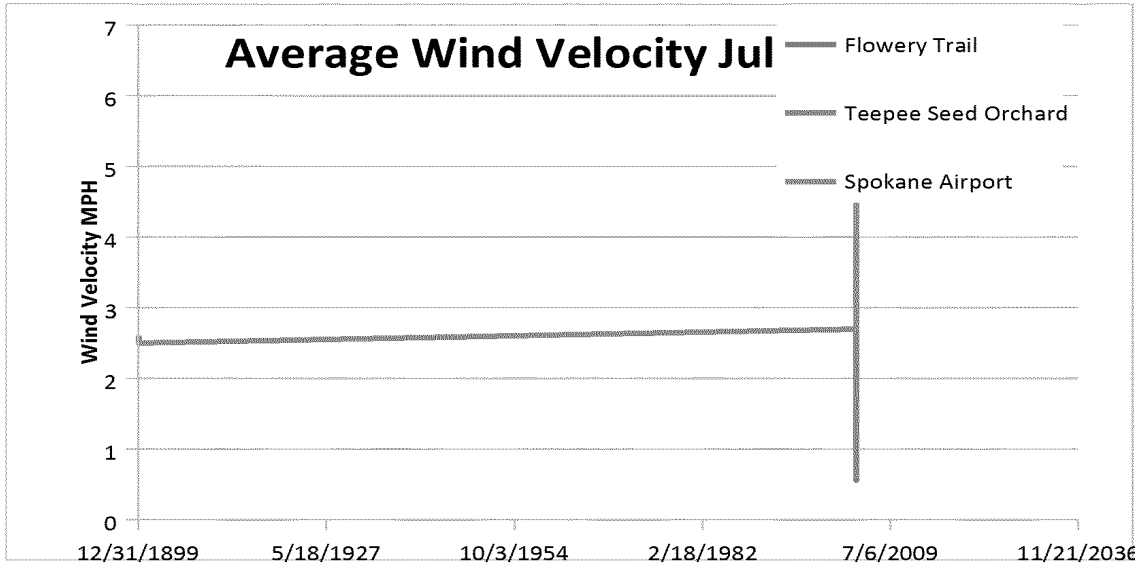
Daily Comparison: 0.83 C, 0.72C, 0.74 C exceedances on August 27, 28, & 29 respectively; greater than Kalispel border reduction by 0.54C, 0.43 C and 0.45 C, respectively. **No obvious time lag in graph**. This exceedance occurs as the hydrograph is still rising from the storm. The exceedance is not caused by an increase in water temperature in the "dams in" model simulation, river temperatures are decreasing in that scenario, but rather temperatures do not reduce as much as in the natural conditions simulation within this 3 day time period.



July 11, 2004:

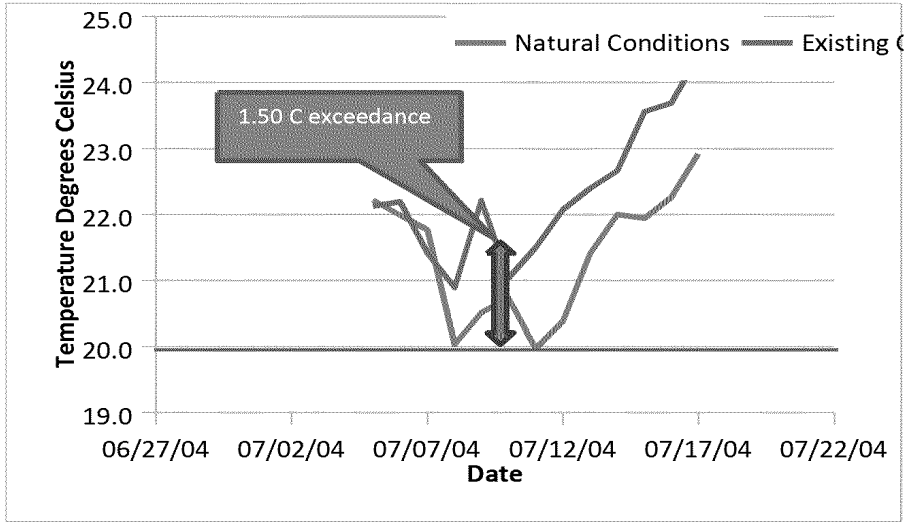
There is one exceedance of the state's 20C daily maximum criterion on this date at Box Canyon Dam forebay. There is no record of precipitation or increased flow in the river at this time which could explain the cooling trends seen in the graph. Wind can have a significant cooling effect near the water surface, where this exceedance is likely to be located. Data from multiple weather stations that were used in the model show a pattern of increased wind that appears to correspond with the two cooling trends seen in the graph of the model data from this time (See chart of wind data).

The graph of the exceedance shows an oscillation pattern similar to the other graphs showing time lag effects. The natural conditions and existing conditions results are similar in shape and area offset from each other, however the cooling trend in the existing conditions scenario occurs a day earlier than the cooling trend in the natural conditions data. If the two scenarios were aligned to where their low temperature dips were at the same date, there would be no exceedance above the TMDL allocations. It is not clear what model effect caused slowing of the natural conditions water trend to show up later than the existing conditions water in this instance.

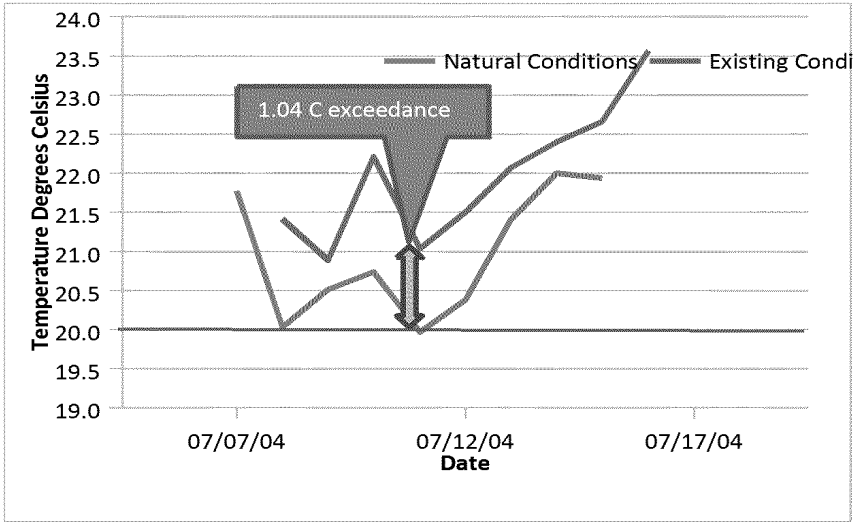


Reach: Box Canyon Forebay
Date: July 11, 2004
Segment: 359
River Mile: 36.4
Applicable Criterion: State daily max 20C
Applicable Allocation: 1.13 C allocation at Box Canyon Dam plus 0.02 C reduction calculated for increased riparian shade = 1.15C

Daily Comparison: 1.50 C exceedance, 0.35 C over allocations.

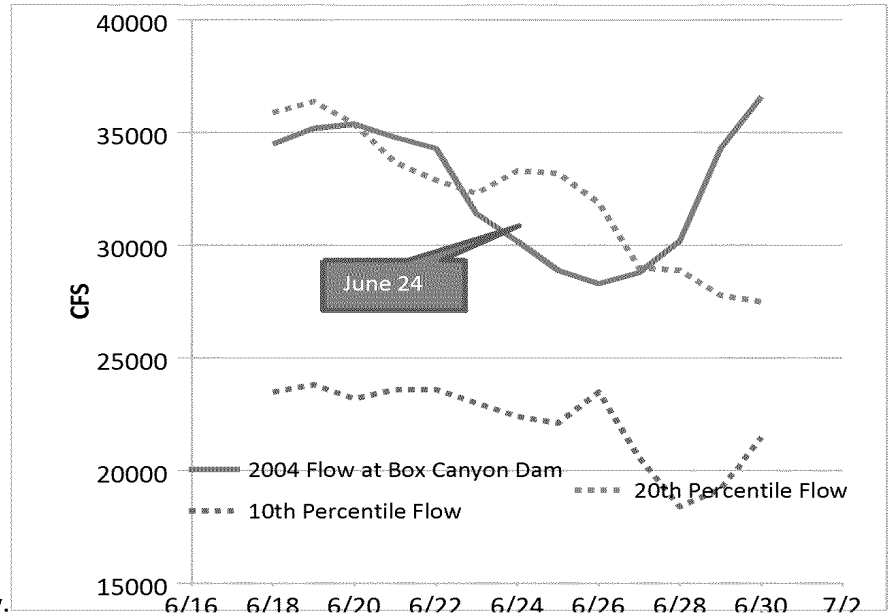


Time Lag adjusted: 1.04 C exceedance; **<u>addressed by allocation</u>**



June 24, 2004:

There is no precipitation nor are there spikes in flow recorded on or near this date. Data on flow a Box Canyon dam show that the exceedance occurs during a relatively low flow, though it is not quite at the 10th percentile flow.



Reach: Box Canyon Forebay
Date: June 24, 2004
Segment: 359
River Mile: 36.4
Applicable Criterion: State daily max 20C
Applicable Allocation: 1.13 C allocation at Box Canyon Dam plus 0.02 C reduction calculated for increased riparian shade= 1.15 C

Daily Comparison: 1.33 C exceedance, 0.18 C over allocations, 0.06 C over the TMDL allocation if the (0.12 C) portion of the human use allowance given to Box Canyon Dam is considered. **There is no obvious time lag in the graph**.